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Eliciting and storing operative information from expert surgeons using surgical scripts: A content analysis study

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Abstract *Introduction:* Surgical trainees learn many of the minutiae of operative technique at the operating table. As trainees' operating exposure decreases, so will the opportunity for the trainee to work with and learn from a range of different surgeons. Surgical scripts provide a complementary source of expert operative information from individual surgeons. This pilot study examines whether a surgical script is an effective way of eliciting the combined operative information from a group of surgical experts.
Methods: One operative step was taken from a surgical script: tracing the right ureter in a right hemicolectomy. A group of surgeons were asked to review the information supporting this step in the script and to add all their own hints and tips for the step. The comments elicited from the surgeons were subjected to content analysis.
Results: The original script contained 15 points of information backing up the ureter step, more than 3 times as many as in the most detailed operative textbook found. Nineteen surgeons contributed 50 additional comments, providing more detail, extra information, alternative techniques and different opinions. Some of the comments have been incorporated into a revised script.
Conclusion: This pilot study showed that a surgical script is an effective way of eliciting and storing detailed operative information from a group of surgeons. The relevance of these findings is discussed. The resulting scripts on line should be helpful in optimising trainees' operating time.

Introduction

Of the great many skills to be acquired by the trainee surgeon, none is more essential than an ability to operate. Traditionally, the broad principles of operations were obtained from sources such as operative textbooks, manuals, and How I Do It articles. Most of the minutiae of operative technique, not being formally recorded, were acquired at the operating table, either by assisting at or by performing the operations, under expert guidance. By working with a series of expert surgeons, trainees were exposed to the different techniques, different approaches and differences of opinion among their seniors, which are integral to the ever evolving progress of surgery.

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However, as trainees' operating exposure falls, particularly due to the European Directive on shorter working hours, inevitably the trainees' contact with a range of expert surgeons at the operating table will diminish.[1] To optimise the trainees' limited operating time, complementary methods of operative training are being developed. So far, much emphasis has been placed on developments such as multimedia and virtual reality training, operative assessments, error detection and consensus statements.[2–6] However, the actual operative information, defined in its broadest sense to mean everything that a fully trained surgeon uses when operating, is underprovided in most of these training modalities. Typically, an operative surgical textbook, or a How I Do It article describes a major operation in 2—10 pages.[7,8] Multimedia programs, despite their impressive graphics, usually contain similar amounts of information to the above, and operative assessment and error detection methods contain very little. In a surgical script, which attempted to record all the information that one surgeon used, the number of pages of information increased tenfold, providing more than 2000 pieces of operative information for a major operation.[9] Whether a particular mass of information correlates with expertise is not established, although an information curve, similar to that of a learning curve, has been suggested.[10] To what degree the information used by a group of surgeons exceeds that of one surgeon has again not been established. Also the amount of disagreement among surgeons concerning the details of an operation is unknown. Judging by the limited recommendations of consensus statements concerning even broad aspects of surgical practice, the amount of disagreement over operative details is likely to be high.

Expert surgeons may not be aware of what information they are using while performing intricate steps in an operation. Trainees may not be aware of gaps in their own operative information that would impair operating performance. Identifying the elements of such information would help provide a structure to assist both groups.

A general classification of information, as used by the information scientist, includes data (e.g. the digit 4), information proper or data in context (e.g. 4 cm), knowledge (information gained by experience), skills, heuristics (rules of thumb), complex decisions and inferences.[11] The educationalist rather rigidly classifies information into that which can be recorded (explicit information) and that which cannot (implicit or tacit information). However, some implicit information may be convertible into the explicit form.[12] One attempt to identify the elements of surgical information, based on the information backing up the steps of over 50 surgical scripts, proposed 25 categories of information.[9] These included basic categories covering why a particular step in an operation was being performed, what instruments and materials to use, where to start, how to perform the step, land marks, and end points. Further categories consisted of problem-avoiding information such as decision making, inferences, dangers, tips, hints, dos and don'ts. Further categories covered problem-solving information such as detecting and correcting errors, dealing with the unexpected, and when to call for help. This classification was not considered comprehensive.

Eliciting information in depth is well known to be very time-consuming, both for the surgical experts and the investigators. It requires an explanation of what type of information is required and usually a series of interviews. In addition, surgical experts need convincing that they are not under investigation, which might reduce their cooperation.[11] A surgical script has several inherent advantages. It provides an example of what level of information was required from the collaborating surgeon. It places the surgeon in the positive role of judge and advisor, rather than the passive role of defendant, which should optimise compliance. The script material would take the place of interviews. Information could be elicited from several experts simultaneously by sending multiple copies of script material.

This study tests the hypothesis that a surgical script is an efficient means of eliciting detailed operative information from a group of expert surgeons.

Methods

This study examined information from a major operation. An open right hemicolectomy was chosen as an example of a well-established procedure, and a useful benchmark for evaluating trainees. ''Trace the right ureter'' was chosen as a discrete, identifiable, and important step in the operation. The step was taken from a 67 page surgical script describing this operation written by the surgical author, viewable on line.[13] The ureter step contained 15 points of back up information (see Appendix 1).

Forty consultant colo-rectal surgeons were sent a copy of the step from the script. They were asked to comment on the step and the back up information. They were invited to add all the information, tips, anecdotes, and dos and don'ts that they used when performing the step. They were not specifically asked to comment on every point in the script.

A content analysis was performed on the information to establish the extent of coverage of the step.[14] The unit of analysis concerning tracing the right ureter was defined as a cluster of information providing a useful piece of surgical advice. For clarity, such a cluster of information in the original script was called a ''surgical point'', and in the replies from the surgeons, a ''surgical comment''. Decisions as to what comprised surgical information were taken by the surgical author.

Results

Given the qualitative nature of this study, the analyses are limited to descriptive statistics.

Nineteen of the 40 surgeons returned the script step with their comments (see Appendix 2). These 19 surgeons provided 63 comments about the step (mean 3.3 comments per surgeon, range 1—7). Adjusting for 13 comments made by more than one surgeon (2—5 surgeons per duplicated comment), there were 50 unique comments (mean 2.6 unique comments per surgeon, range 1—7). These comments referred not only to the 15 points supporting the script, but also to the step itself (see Appendix 2). Two unexpected comments were placed in a miscellaneous group (see Appendix 2).

Of the 50 unique comments, one identified an error in the script, 4 specifically agreed with some point in the

script, 5 disagreed partially, and 4 disagreed completely. Sixteen comments added to the information already in the script. Five fell into a miscellaneous group. Fifteen described alternative techniques, 5 comments providing different levels of detail and 10 showing differences of opinion among the surgeons. Five of the 50 comments suggested that tracing the ureter at all was either completely unnecessary, or unnecessary if specific conditions were met.

Forty-six of the unique comments fell within the categories of information of the earlier surgical classification. The remaining 4 comments led to the creation of 4 new information categories. What are the anatomy, physiology, and pathology (of the ureter)? What does it (the ureter) look and feel like? What does it (the ureter) do? Notable cases. These categories have now been added to the classification.

The surgical author disagreed with 10 of the 50 comments or felt they were unhelpful. For instance, the 5 comments against identifying the ureter were felt to be valid under exceptional circumstances only. Of the remaining 40 comments, one was used to correct an error in the script. Thirteen comments giving useful hints and tips were edited into existing points in the ureter step. Thirteen comments describing other ways of dealing with a compressed or invaded ureter were edited into 2 new points in the ureter step. Ten comments describing other ways of mobilisation of the colon were edited into other parts of the script. Three comments related to using different equipment were not included.

Discussion

Since all the reviewers are practising consultant surgeons, accustomed to teaching trainees, the information provided in their comments is likely to resemble the information they would impart at the operating table.

This pilot study has achieved its primary aim by eliciting nearly three times as much information as was present in the original script step, which itself may contain three or more times the information in individual operative textbook. The large amount of information, in part, included comments that were quite similar, but which, nevertheless, contained nuances of meaning that were worth preserving. In addition, the reviewers made comments in relation to tracing the ureter that brought in information from elsewhere in the operation, such as methods of mobilising the colon. The same amount of information might have been elicited by a simple questionnaire and the quality may have been similar, but the amount of disagreement might not have been displayed so clearly. The gathered information poses many interesting questions and opens avenues for further study.

Less than a quarter of the comments were made by more than one surgeon. This suggests that there is more information to come. The top of a postulated information curve does not appear to have been reached yet. The amount of extra information contributed by an individual surgeon was relatively small, suggesting that a trainee who had learned from a script and then worked with one surgeon instead of three, say, might only decrease his information pool by 25% or so. On the other hand, eliciting information from a greater number of surgeons could greatly increase the relative benefit of a script. This now a reality, with the launching of an online surgical encyclopedia.[15] The question rises about how the trainees could absorb such a mass of information without overload. The format of a script allows the trainee to move progressively from overview, through operative sections and steps to the backup information. The script can be used, in part or in whole, before or after an operation and can be searched for specific information. The information can be communicated in interactive multimedia formats.[16] In practice, at present the main problem is not an overload of information, but a shortage, which is one of the main causes of operative errors.[17] Looking ahead, a scriptmaster may be necessary to supervise the quantity and content of information in online scripts.

Nearly 20% of the comments disagreed with the points in the ureter step, or in the step itself. Half of them referred to points that they considered only partly true and provided more information clarifying matters. The rest reflected different approaches to cancer surgery and its management. The surgical author also disagreed with 10 comments from the reviewers. This amount of disagreement is probably similar at the operating table. To prevent a junior trainee being confused by different sources of information contradicting each other, versions of scripts for beginners could be made in a somewhat simpler and more didactic form. Versions containing all the disagreements could be reserved for professional development of the more experienced trainee and the expert.

Of the new elements of operative information identified in this study, the ''What are the anatomy, physiology and pathology'' category provides information at point of use, which may have been poorly provided in undergraduate courses.[18] The ''notable cases'' category provides trainees with information to solve problems using the expert's way of referral to past cases, rather than using the beginner's method of applying logic based on first principles.[19] The ''What does it (the ureter) look like'' category reminds the surgeon of the way he uses all his senses when operating. More categories will doubtless emerge to elicit information more effectively and to guide the writers and users of further scripts.

There is no direct evidence that a trainee will become expert more quickly after absorbing information from scripts and indeed some trainees may dislike this approach. But the authors consider that if trainees spent the time of today's lost operating session reading the operating information from groups of expert surgeons, they would optimise the session of tomorrow.

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Appendix 1

Fifteen points of information backing up the right ureter step in the original right hemicolectomy script

Step 7.15: Trace the right ureter

Point 1 Identify the ureter as it runs down behind the ascending colon and caecum.
Point 2 It is deeper than the testicular/ovarian vessels.
Point 3 In the upper half of the dissection it is lateral to the gonadal vessels.
Point 4 In the lower half, it runs medially.
Point 5 It is thicker, being over 5 mm in diameter.
Point 6 It is whiter than the testicular artery and has very fine blood vessels running along it.
Point 7 It may be adherent to the medial leaf of the paracolic peritoneum as you pull that tissue medially.
Point 8 Prod it to show its characteristic downward peristaltic contractions.
Point 9 Trace it from the kidney to the lower end of the peritoneal incision as it runs over the right common iliac artery at the pelvic brim and into the pelvis.
Point 10 Make sure it is out of danger, but do not deliberately free it from its bed.
Point 11 If you cannot find the ureter: ask for help from a more experienced surgeon.
Point 12 If the ureter is compressed by the tumour: dissect the ureter free.
Point 13 If the ureter is definitely invaded by tumour: remove the invaded ureter in continuity with the tumour.
Point 14 Tie off the proximal ureter.
Point 15 Consider a right nephrectomy.

Appendix 2

Comments by 19 surgeons on the whole script step

Step 7.1: Trace the right ureter

- Two surgeons disagreed completely with performing this step at all. They stated that the correct plane of dissection was anterior to, or more superficial than, the ureter.
- Three surgeons disagreed with performing this step under the following conditions:
- If the dissection is superficial to the gonadal vessels, there is no need to look for the ureter.
- If you follow Toldt's plane, you will be free of the fourth part of the duodenum and the ureter/ gonadal vessels inferiorly.
- If there is no hydronephrosis on CT/US scan, do not actively seek the ureter.

  Point 1: identify the ureter as it runs down the lateral paracolic gutter.
- Three surgeons disagreed with this description of the path of the ureter. This misleading description has now been reworded.

  Point 2: the ureter is deeper than the testicular/ovarian vessels.
- No comment.

  Point 3: in the upper half of the dissection the ureter is lateral to the gonadal vessels
- No comment

  Point 4: in the lower half, the ureter runs medially
- One surgeon said that the ureter did not always run medially.

  Point 5: the ureter is thicker than the gonadal vessels, being over 5 mm in diameter.
- One surgeon stated that width was not a criterion for identification of the ureter.
- A second surgeon suggested that if the ureter was wider than normal, it might be obstructed and was also difficult to identify.

  Point 6: if the ureter is narrower than this, there may be a double ureter.
- One surgeon agreed, but pointed out the danger of missing the plane of the second ureter.

  Point 7: the ureter is whiter than the testicular artery.
- One surgeon commented that the ureter was not white if there had been right renal infection

  Point 8: the ureter has very fine blood vessels running along it.
- No comment

  Point 9: the ureter may be adherent to the medial leaf of the paracolic peritoneum as you pull that tissue medially.
- One surgeon warned not to overmobilise the colon.
- A second surgeon recommended lifting the colon up to behind the duodenum

  Point 19: prod it to show its characteristic downward peristaltic contractions.
- Three surgeons recommended squeezing the ureter gently with non-toothed forceps to show peristalsis (vermiculations).
- A fourth used de Bakey forceps.
- A fifth surgeon suggested that bowstringing or pinging the ureter would help identify it in a fat person and prevent bleeding from the gonadal vessels.
- A sixth surgeon recommended standing on the opposite side of the patient to the ureter and pinching the ureter, which feels like a cord. This should be done whenever a ureter was available.

  Point 11: trace the ureter from the kidney to the lower end of the peritoneal incision as it runs over the right

common iliac artery at the pelvic brim and into the pelvis.
- Two surgeons stated it was not necessary to dissect up as far as the kidney.
- Another stressed the need to dissect down as far as the pelvic brim in a fat patient.
- Another recommended starting at the pelvic brim and following the ureter upwards until it was out of the field of dissection.
- Another surgeon divided the peritoneal reflection below the caecum, before identifying the ureter at the pelvic brim.
- Another identified the ureter under the peritoneum as it ran across the iliac vessels, before it even went behind the caecum.
- Another surgeon stated that, if the pathology invaded the retroperitoneum, he mobilised the ileo-caecal pole and identified the ureter at the pelvic brim, where it crossed the iliac vessels.
- Two surgeons stressed the need to operate in the correct plane, bringing the surgeon to Toldt's plane.
- Another surgeon suggested approaching the ureter according to the site of the tumour. For a tumour in the caecal area, he started the disssection from the hepatic flexure. For a tumour in the mid-ascending colon or above, he started at the caecum.
- The practice of a ninth surgeon was to alter the approach according to the size of the tumour. For a bulky tumour, he identified the ureter as low as was necessary and used a plastic sling to identify it proximally where it ran down behind the tumour (usually medially). For smaller tumours, he divided the peritoneum laterally and ligated the bunch of tissue anchoring the hepatic flexure. By mobilising the bowel medially in these ways, he identified the ureter at the pelvic brim.
- Another dissected behind the caecum, appendix, terminal ileum and all the way up to the duodenum, where the vessels run out of the pancreas. In that way, staying in this plane would identify the ureter and avoid the risk of damaging it. Only after doing this would he divide the lateral white line. He felt that starting from the direction of the white line was why the ureter was damaged, as it was raised up (with the peritoneum) in that plane.
- An eleventh surgeon stressed the need to define the fatty mesocolic package that belongs to the bowel. Following this glistening plane would keep the surgeon free of the fourth part of the duodenum and the ureter/gonadal vessels inferiorly.

  Point 12: make sure it is out of danger, but do not deliberately free it from its bed.
- No comment.

  Point 13: if you cannot find the ureter, ask for help from a more experienced surgeon
- One surgeon recommended that, when seeking the ureter, not to head for it directly, but to approach it from the left or the right. In that way, if the ureter is not found, the surgeon will know which way to dissect.
- Another pointed out that failure to find the ureter may mean an absent kidney.
- A third stated that, if in doubt about the whereabouts of the ureter, it was safe if one stayed anterior to the duodenal loop.

  Point 14: if the ureter is compressed by the tumour, dissect the ureter free.
- Three surgeons warned that if the ureter was likely to be involved, to have a urologist on hand in these increasingly litigious times.
- One surgeon simply suggested discussing any ureteric involvement with a more experienced person.
- One surgeon pointed out that hydronephrosis on a preop CT/US scan should alert the surgeon to ureteric involvement.
- A sixth surgeon stated that if the ureter was compressed by, or adherent to the tumour, he decided whether this was due to tumour infiltration or inflammatory reaction, and whether complete oncological clearance could be achieved. If thought to be inflammatory, then he carefully freed the ureter, keeping very close to it to avoid breaching the outer margin of the tumour.

  Point 15: if the ureter is definitely invaded by tumour, remove the invaded ureter in continuity with the tumour, tie off the proximal ureter, consider a right nephrectomy.
- The above surgeon continued describing his management of a compressed or invaded ureter, by stating that if due to tumour infiltration, and oncological clearance could be achieved, then the segment of ureter could be excised. Usually this was very small and consideration could be given to an end to end anastomosis, or transposition, although, in some cases it may be necessary to consider a nephrectomy.
- One surgeon suggested marking the area with clips.
- Another surgeon recommended excising up to 2 cm of invaded ureter and joining the ends over a pigtail stent. If more than 2 cm of ureter were involved, he would possibly tie off the ureter.
- Two surgeons agreed about tying off the proximal ureter, one of them making the proviso that there was a normal IVP on the left.
- Two surgeons advised consulting with a urologist first.
- Two others also suggested joining the right ureter to the left one.
- A tenth surgeon recommended more specifically a right to left uretero-ureterostomy over a JJ stent, which was easy for a urologist.
- One surgeon thought tying off the ureter was probably inappropriate, but approved of a nephrectomy.
- One surgeon disagreed with a nephrectomy.
- A further surgeon suggested consulting with a urologist before performing a nephrectomy.
- A fourteenth surgeon mentioned transplanting the kidney into the pelvis.

  Miscellaneous
- One surgeon suggested taking operative photographs.
- One surgeon recommended using bipolar scissors to avoid bleeding from blunt disssection.
- One surgeon stated that if bleeding was encountered, the dissection was too posterior, in which case ureteric damage was more likely.
- One surgeon quoted notable cases, saying that the greatest hazard in a right hemicolectomy was tearing of large vein(s) which run between the gastro-epiploics and the root of the transverse mesocolon. He knew of one death from haemorrhage here and had had to rescue 2 SPRs who had major bleeding in this area.

- Finally a fifth surgeon stated how difficult he found the task of providing information of this type. He felt that the inevitable didacticism which arose from the need for brevity could be dangerous. There were so many ''ifs'' and ''buts'' in cancer surgery.

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